RESEARCH HIGHLIGHT

February 2006

Technical Series 06-103

IDENTIFYING AND REMOVING POLLUTANTS FROM HEAT RECOVERY VENTILATORS

INTRODUCTION

Canadians spend long periods of time indoors. Poor indoor air quality in houses can lead to respiratory illness. Factors that degrade indoor air quality include allergens such as mold, an abundance of chemical pollutants (cleaners, solvents, air fresheners, etc.), and low ventilation rates. Dedicated ventilation systems were developed to improve indoor air quality. These systems provide balanced supply and exhaust ventilation to the entire house via an air exchanger or heat recovery ventilator (HRV) and ductwork.

While dedicated ventilation systems are designed to provide better air quality, their related components are rarely investigated. Do they harbour allergens or other sensitizers? Is regular cleaning and maintenance of these systems effective enough to remove these pollutants? This Nova Scotia study investigated the presence of allergens in HRV systems. It also examined two styles of duct cleaning equipment and their ability to remove pollutants, such as dust and mold, from rigid and flexible ductwork.

RESEARCH PROGRAM

The objectives of this 1999 study were:

- to determine whether dedicated ventilation systems harbour unhealthy levels of dust and mold;
- to discover whether existing duct cleaning methods are successful at lowering those levels; and
- to identify ways to improve the installation and maintenance of HRV units.

The study included six conventionally built homes and four R-2000-certified homes of different types and styles— all built between 1987 and 1997— and all owned or occupied by the same household for at least 12 months prior to the site visit. The houses were tested for air and surface mold counts using an RCS air sampler and typical swab collection systems. Two of the 10 houses were retested several times over 15 months.

Air samples were taken at four common sites in each house, before and after cleaning. The air sample at the exterior hood of the fresh air intake was used as a control point to determine the general level of mold-forming colonies throughout the house.

Surface swabs were taken at seven common sites in each house.

A. Ductwork at supply, main bedroom
B. Ductwork at supply, main living area
C. Ductwork at exhaust, kitchen
D. Ductwork at exhaust, main bathroom
E. HRV core
F. Insulated flex duct at fresh air intake
G. Supply ductwork at HRV to house

Some houses had more samples taken—where there were obvious signs of mold/mildew growth, or in bedrooms if occupants had respiratory problems.

The ductwork and cores were then cleaned using standard ductwork cleaning apparatus and tested again to validate the success of the cleaning process. Video was taken inside the ductwork before and after the cleaning to determine how much surface dust and mold was removed.

anada

CMHC SCHL
HOME TO CANADIANS

Two cleaning methods were used from four different companies. Both techniques relied on a compressed air wash to dislodge contaminants, and a high-powered vacuum or fan to collect the debris:

Truck-mounted system: Supply and exhaust ducting was disconnected at the house side of the HRV and a flexible duct was attached to each side of the ducting during the cleaning process. The duct ran outside to the truck which contained a fan that removed air from the duct and a series of collection bags to catch the debris.

Portable high-power vacuum: Supply and exhaust ducting was disconnected at the house side of the HRV and a flexible duct was attached to each side of the ducting during the cleaning process. This duct ran to a portable high-power vacuum located in the same room as the HRV. First, a series of filters (a bulk catcher, a bag filter and a HEPA filter) collected debris and contaminants, and then the exhausted air was returned to the room.

Both systems were designed to clean forced hot air heating and air conditioning systems. However, over the past several years, they have been used for cleaning the smaller ductwork of dedicated ventilation systems. Equipment was adapted through ductwork connections and pressure modulation.

The average time required for cleaning the ductwork was 3.5 hours, at an average cost of $200 (1998 prices).

Results

Cleaning

In each house, the flex duct, which runs from the HRV to the fresh air intake hood, was heavily contaminated with bugs, dust, dirt and lint. The flex ducting was very difficult to clean, especially where duct runs were long and inaccessible.

The air intake hoods located less than 600 mm (24 in.) above grade were dirtier than those at 1,200 mm (48 in.) above finished grade. In the study, intake hoods located above 1,200 mm did not seem to be as heavily contaminated or blocked.

Blockage of the fresh air intake hood screen (leaves, dog hair and other debris) affected airflows differently when the HRV was operated on low and high speed. The airflow remained relatively the same on low speed before and after the blockage was removed. With the HRV running on high speed, the airflow on the supply side was severely restricted prior to the screen being cleaned. With partial blockage, the exhaust airflow was typically twice that of the supply side airflow. A system operating in this unbalanced mode creates a negative pressure in the house.

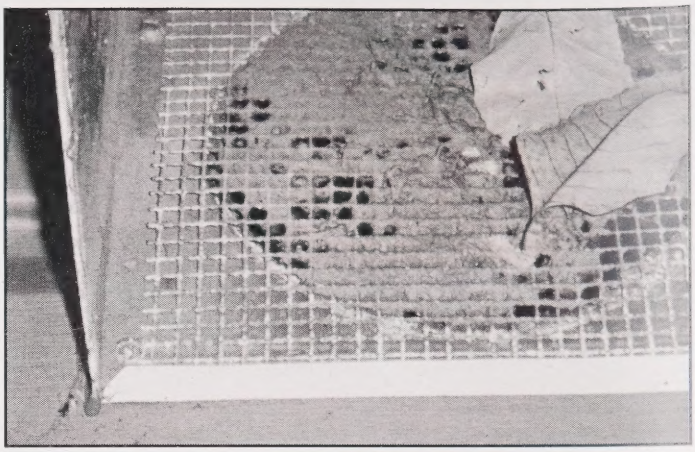

Figure 1: Blocked HRV intake

Viewing of the videotapes from the pre-and post-cleaning of the ductwork revealed that both cleaning methods had visible effectiveness of 50 to 60 per cent. Success depended on the placement of the air wash and high-powered vacuum, which was determined by the design and accessibility of the ductwork.

The ductwork on the exhaust side of all systems in the study was found to be heavily contaminated because there were no filters installed on exhaust grilles. This resulted in dirt, dust and lint being found throughout the ductwork. All R-2000 houses had a filter on the kitchen exhaust grille, but only two had filters on the bathroom exhaust grille. The ductwork mold counts at these locations were lower than at non-filtered exhaust grilles, implying the filters had limited the amount of contaminants entering the ductwork.

One house system was sprayed with an antimicrobial agent, without the consultant being aware of it. The spraying was only effective close to the immediate spray radius and did not permeate the whole ductwork system.

Although there exist many federal and provincial publications—along with manufacturer's manuals dealing with the operation and maintenance of central ventilation systems—homeowners did not maintain their systems on a regular basis. When systems were maintained, most attention was given to the filters in the HRV box itself (filters were cleaned in 6 of the10 houses). HRV cores and ductwork were rarely cleaned, and only three intake grilles were cleaned regularly.

Results

Mold (refer to the list detailing surface swab sites on Page 1)

Pre-cleaning samples showed that, on average, the highest surface mold counts were at the HRV core (site E) and at the fresh air intake (site F). The living room, kitchen and supply from HRV to house (sites B, C and G) were lower. Most swab sites showed a reduction in mold counts after ductwork cleaning, except in the master bedroom and at supply air sites (sites A and F).

High concentrations of mold in post-cleaning air samples are most likely due to the testing being done within two hours of cleaning. One house was retested three days after cleaning to show only a minimal amount of mold genera detectable.

Two houses (House 03C and House 03R) were tested 5 times over a 15-month period. Both houses showed a general trend of lowered levels of surface mold at the main bedroom supply, living room supply, kitchen exhaust and bathroom exhaust (sites A, B, C and D) over the study period. The surface mold counts at the HRV core, the air intake and the supply to house (sites E, F and G) varied considerably over the seasons. Although both houses showed a significant reduction in CFUs (colony forming units) after the initial cleaning, House 03C had a fivefold increase in CFUs at the intake hood (site F) in the autumn after the cleaning. This dramatic increase was followed by an equally dramatic decrease at the next sampling—a thousand times lower in February than in October. This can be attributed to the fact that the intake hood on this house is low to the ground (less than 600 mm/24 in. above grade), and is located under a deck. These two factors mean that the intake hood is pulling moist, contaminant-laden air into the fresh air duct, and the sharp increase and decrease in the CFUs at the testing site is due to seasonal conditions. There was a small corresponding increase in CFUs in the HRV core and at the supply duct (sites E and G).

House 03R had an intake duct 2,500 mm (98 in.) above grade. Although pre- and post-cleaning samples showed higher CFUs at this site in this house when compared to House 03C, the autumn level of CFUs is minute. When tested in the autumn, the samples taken from the HRV core and supply duct sites (sites E and G) show corresponding reductions in CFUs.

CONCLUSIONS

Results of the study indicate the following.

- Mold counts were high in the ductwork and cores, with consistently higher counts found in the fresh air supply duct to the HRV (typically a length of flex duct).
- There was no correlation between the levels of the surface mold concentrations in the duct systems and the samples of airborne mold taken in the house. Based on current guidelines, the airborne mold sampling results were inconclusive as to whether any of the houses presented levels that could cause health problems.
- Homeowners are uneducated on maintenance requirements for their HRVs.
- Current duct cleaning systems are not effective for smaller diameter ductwork.

IMPLICATIONS FOR THE HOUSING INDUSTRY

HRV manufacturers and standards committees should consider means to keep HRV ductwork clean and accessible, especially on the intake side. An insulated rigid metal duct would be much easier to maintain than flex ducting. A restriction on the use of flex ducting would also improve the performance of the HRV. Having a quick release duct to HRV connection would assist with access and cleaning.

Installing an outdoor filter on the fresh air supply, having a higher ground clearance requirement for the fresh air supply and pre-filters on HRV exhaust grilles in the house would reduce the levels of contaminants in the system.

To ensure that consumers are getting the best value and performance out of HRV systems, manufacturers, installers and builders have to improve education and awareness on the operation and maintenance of these systems.

CMHC Project Manager: Don Fugler

Research Consultant: Terry Watters, Sustainable Housing and Education Consultants Ltd.

Housing Research at CMHC

Under Part IX of the *National Housing Act*, the Government of Canada provides funds to CMHC to conduct research into the social, economic and technical aspects of housing and related fields, and to undertake the publishing and distribution of the results of this research.

This fact sheet is one of a series intended to inform you of the nature and scope of CMHC's research.

To find more *Research Highlights* plus a wide variety of information products, visit our website at

www.cmhc.ca

or contact:

Canada Mortgage and Housing Corporation
700 Montreal Road
Ottawa, Ontario
K1A 0P7

Phone: 1 800 668-2642
Fax: 1 800 245-9274

Printed in Canada
Produced by CMHC 06-02-06

OUR WEBSITE ADDRESS: www.cmhc.ca

64994